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(19) (CA) **CANADIAN PATENT** (12)

(54) Material Surface Modification

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(73) Same as inventor

(57) 16 Claims

ABSTRACT

A process wherein the surface of suitable materials can be modified for adhesive bonding by keying the surface through the deliberate creation of burrs of various and particular shapes. A large number of burrs can be created in a single operation using a multiple edged tool. Interlocking of these surface burrs on two adherents provides internal reinforcement of an adhesive bond and self-clamping of the materials so modified. This process is highly suited for production adhesive bonding.

SPECIFICATION

In a surface modification process to prepare certain materials e.g. metals, for bonding it is common to employ some form of mechanical preparation e.g. abrasive blasting, to 'key' the surface allowing for increasing adhesion (a combination of physical interactions and chemical reactions) of the adherend (the material being joined) and the adhesive . However the surface so prepared is highly random when viewed in microscopic detail, with each differently sized and oriented abrasive particle being blasted at the material's surface, leaving a different imprint or pit none of which are necessarily the optimum shape for maximizing adhesive bonding. Thus the surface is roughened and pitted but not in an engineered or optimum manner. Furthermore said process will allow for air entrapment under the adhesive which in turn prevents perfect 'wetting' or contact between the adhesive and the depths of the air-entrapping pits. Other preparation involves the use of wire brushing to roughen the surface but for much the same reasons the abherends (the two materials being joined) are not optimized for the bonding process. Grinding and machining also leave a very roughened surface but random in detail, not the optimum surface. Furthermore none of these processes address the clamping requirement in adhesive bonding where often relatively long periods of clamping time are required for the adhesive to fully cure. Clamping prevents relative movement of the pieces. Moreover these processes do not allow for surface embedment of the keyed surface of a hard, stiff material, e.g. metal, so modified, into another lower melting point material, e.g. a plastic. Furthermore these processes do not allow an effective means of effectively engaging an added fibrous material which may be desirable in said bonding.

I have found these limitations can be overcome by using the process disclosed herein which I call "BondFace" which provides a means of modifying by 'keying' the surface of many materials through the use of a tool to 'cut' or 'plow' a 'path', 'groove', 'channel' or 'furrow' into the surface simultaneously displacing the material's surface creating a 'burr' or 'barb' useful as a 'key' or 'grip' for adhesive adhesion to said materials. The formed burr is not severed from said material. The process thus raises a 'burr' or 'non-severed chip' e.g. "a rough or sharp edge left by a cutting tool" in the material's surface where the tool was applied, to provide a 'grip' or 'key' for adhesive bonding. By this means a material's surface can be modified to comprise multiple burrs, creating a keyed surface, by the repeated application of the tool to the material. The tool's cutting edge used to create said keying burrs can be designed to provide a burr of specific shape, size and cross section allowing surface keying for specific requirements. The advantage of this process is that keyed surfaces can be created with burrs formed in the abherends, in the size, quantity and location required. Moreover the burrs produced may be formed to a hook shaped key to allow engagement with other suitable materials, e.g. fabrics. Assembly pressure applied to keyed surfaces will cause burrs to crush about one another forming a keyed interface matrix of integrally formed fiber-like reinforcement for the adhesive with self-clamping of the pieces. This will then allow the bonding and clamping operations to be substantially combined lowering costs and increasing joint strength and thus leading to cheaper end-products of increased integrity. Other media, e.g. inorganic fibers, can be easily incorporated into said key-burred surfaces where adhesive and fiber captured by reclosing the burrs using sufficient assembly force, also produce improved joint strength and end-product integrity. Large areas of material can be keyed using a tool designed with

multiple cutting edges to simultaneously create multiple burrs- there being no reasonable upper limit. Moreover this process allows for another unique type of bonding between two different base materials, e.g. a metal and a plastic, where the 'keyed by burring' metal is heated to a sufficient temperature to cause each burr to melt it's way into said plastic which will 'flow' about the burr and then solidify upon cooling -entrapping and embedding each burr so keying the pieces together.. By this manner materials can be joined even where no suitable adhesive exists. Furthermore the tool may be operated when heated to a temperature sufficient to allow key-burring of normally brittle material, e.g. certain plastics.. An added feature of the process allows that the burrs can be formed in a random pattern or in a highly regular pattern. The regular pattern would allow a high percentage of engagement of opposing burrs on two surfaces when said surfaces are pressed together. However when the second surface is not involved, e.g. paste metal-filler compound, then the random pattern will allow a simpler, portable tool to key the surface..

In drawings which illustrate embodiments of the invention, Figure **1** shows an orthographic view of the preferred embodiment of a single burr in thin sheet material, Figure **2** shows the same embodiment in multiple form, Figures **3, 4, 5,** and **6** show enlarged views of burr where Figure **3** shows a burr in the earliest stage of formation, Figure **4** shows a burr which has been raised further and Figure **5** shows a burr raised still further with a hook shape, Figure **6** shows a burr which has been reclosed entrapping a fiber strand. Figure **7** shows a cross sectional view of two surfaces whose burrs engage, Figure **8** shows an interface mesh of burrs keyed together, Figure **9** shows an embodiment of a tool used to create burrs and Figure **10** shows the same embodiment where the tool has entered the material creating a burr.

The groove **1** cut in stiff material **A** produces a burr **2** of the required shape, size and cross section as defined by the tool's edge design **4** shown in Figures **9** and **10**. This is achieved with a tool apparatus **3** also in Figures **9** and **10**, which has the capacity to cut into **A** to a specific depth **5** in Figures **9** and **10**, creating a **1** and a **2** simultaneously, holding penetration into the material and therefore the depth of **1** and thickness of **1** to a predetermined maximum as defined by **5** in Figures **9** and **10**, and 'peeling' back a layer of **A**. The effect is to pierce and 'peel back' the surface or skin of the **A** with **3** where the design and shape of **4**, produces the shape desired for **2**. In Figure **2** multiples of **2** are depicted over a significant portion of the surface of **A**. Figure **3** is of an enlarged view of **2** to allow further inspection of the detail of **2** and it's relationship to **1** and **A**, **2** has just begun to be 'peeled back' by **3** (not illustrated). Figure **4** shows what happens to **2** when **3** continues to advance against the now raised **2**. Figure **5** depicts the extreme that **2** can be made to be with a pronounced 'hook' to allow meshing with fibrous or 'loop-like' material. Figure **6** depicts **2** reclosed and entrapping a strand of fiber **C**. Figure **6** shows only **A** however the entrapping of **C** between the surfaces of **A** and **B** represents a very powerful feature of this invention. In Figure **7** only two specifically shaped **2**'s of the form shown in Figure **3** are shown engaged but large numbers of **2** would allow substantial strength of mechanical fastening between **A** and **B**. Figure **8** shows the interface between **A** and **B** where multitudes of **2** are entwined about each other in the thin space between the surfaces. Figure **9** shows a tool designed to create a basic **2** where **3** is the tool body with cutting edge **4** and depth-of-cut limiter **5**. To cut a **1** forming a **2** in the surface of **A** , **3** is moved in the direction shown in **3** by the arrow, against a stationary **A** the distance

required to create a **2** of the forms shown in Figures **1**,**3**,**4**,**5** and **7**.

CLAIMS

1. A method of treating a surface of a material which is to be joined to a different surface, comprising the steps of forcing a plurality of cutting edges into a surface portion only of said material to carve a plurality of raised burrs from said material, said burrs remaining securely attached to said material to thereby provide mechanical interlocking means to engage said different surface.

2. The method of Claim 1 wherein the step of forcing a plurality of cutting edges into said surface portion comprises moving said cutting edges in a direction that has a horizontal component sufficient to carve elongated furrows, said furrows providing the material for said burrs and where at least some said burrs remain securely attached to one end of said furrows.

3. The method of Claim 2 wherein said burrs have the form of a hook.

4. The method of Claim 2 wherein said burrs have an essentially involuted form.

5. The method of Claim 1, 2, 3 or 4 wherein said material is a metallic material.

6. The method of Claim 1, 2, 3 or 4 wherein said material is a plastic material.

7. The method of Claim 1, 2, 3 or 4 wherein said cutting edges are forced in different directions thereby carving burrs extending in different directions.

8. The method of of joining a surface of a material to a layer of flexible fibrous material comprising treating said surface by the method of Claims 1, 2, 3 or 4 and clamping said flexible fibrous material to said surface whereby at least some of said burrs are at least partially flattened to trap at least some of said flexible fibrous material beneath said burrs.

9. The method of Claim 1, 2, 3 or 4 further including the step of placing an adhesive on said treated surface.

10. The method of securing first and second surfaces together comprising the steps of treating at least one of said surfaces by the method of one of Claims 1, 2, 3 or 4 and placing an adhesive on said treated surface whereby said adhesive will mechanically engage said burrs, and placing said second surface in contact with said adhesive to thereby form a laminate.

11. The method of Claim 10 wherein both said surfaces are treated.

12. The method of Claim 10 wherein said first and second surfaces are of different material.

13. A composite material comprising at least one material with at least one surface treated by the method of Claim 1, 2, 3 or 4.

14. A composite material made by the method of Claim 8.

15. A composite material made by the method of Claim 10.

16. A composite material made by the method of Claim 11.

Fig. 1

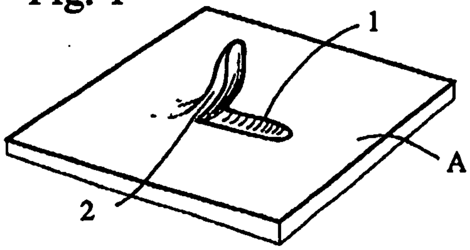

Fig. 2

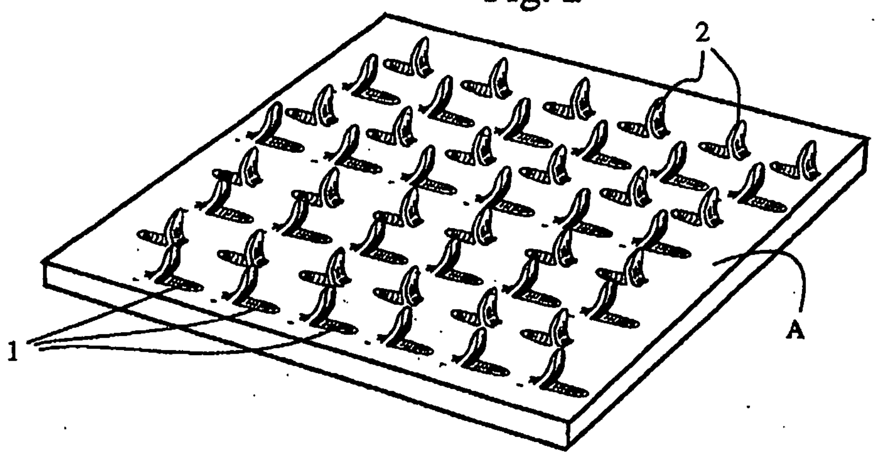

Fig. 3

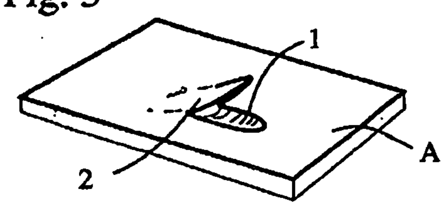

Fig. 4

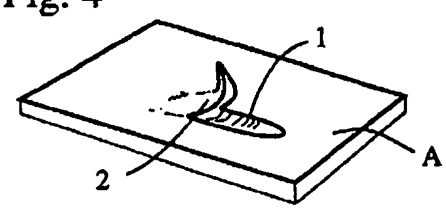

Fig. 5

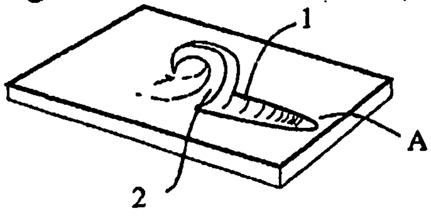

Fig. 6

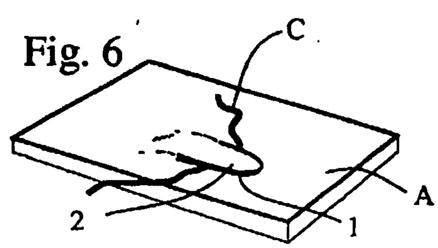

Fig. 7

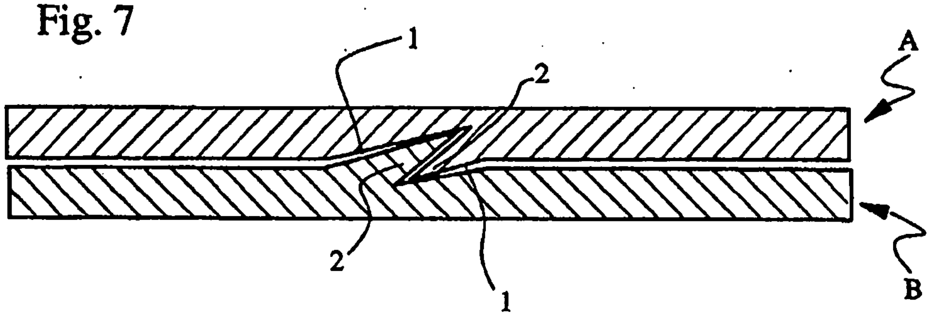

Fig. 8

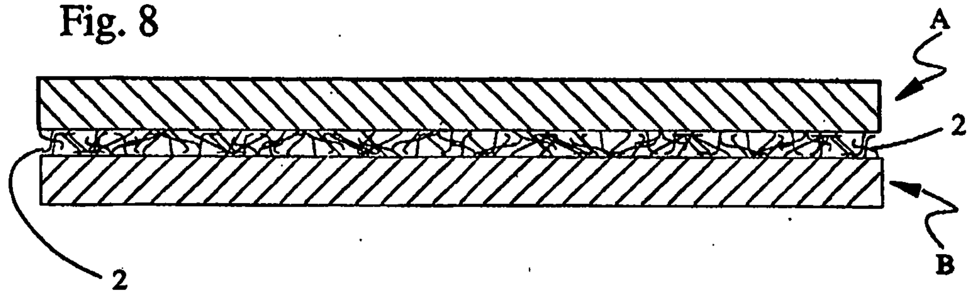

Fig. 9

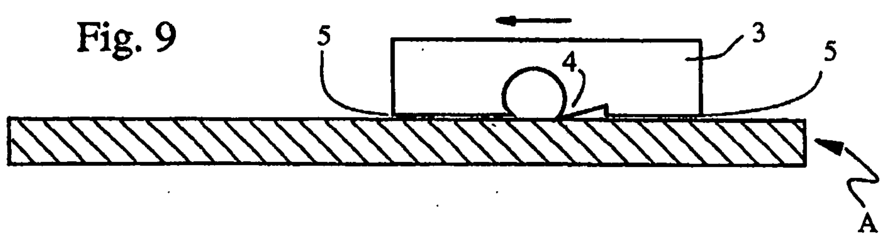

Fig. 10